

1 DYED FABRIC MATERIAL, METHOD OF PRODUCING THE SAME  
2 AND USE OF THE FABRIC MATERIAL IN THE MANUFACTURE OF  
3 SPORTS BALLS

4  
5 The present invention relates to fabric material  
6 particularly suitable for the manufacture of sports  
7 balls and to a method of obtaining the same. More  
8 particularly it relates to a new method of dyeing  
9 woven or not woven material which provides the  
10 material with high visibility characteristics. The  
11 invention also relates to the dyed material thus  
12 obtained and to the use of such material for the  
13 manufacture of sports products and particularly for  
14 the covering of tennis balls.

15  
16 Traditionally, tennis balls were covered with white  
17 woollen felt. Several decades ago yellow felt was  
18 introduced for use on match quality balls and from  
19 the early 1970's balls covered with yellow felt  
20 became increasingly popular. Today, the vast

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1 majority of tennis balls are covered with yellow  
2 felt. Rule 3 of the International Tennis Federation  
3 Rules of Tennis states "The ball shall have a uniform  
4 outer surface consisting of a fabric cover and shall  
5 be white or yellow in colour...".

6  
7 The felt used on tennis balls was previously made  
8 from wool. Increased wear properties are obtained by  
9 including a proportion of synthetic fibres in the  
10 felt, and nowadays such felt is usually made of a  
11 mixture of wool and nylon fibres. The proportions of  
12 wool and synthetic fibres used to produce the felt  
13 can vary, but typically a ratio of 40:60 to 60:40 can  
14 be used (by weight of weft yarn). It is desirable  
15 that the side of the felt termed the "back" (which is  
16 the side which will be stuck to the ball) is made of  
17 a material which provides good adhesion when it is  
18 glued on the internal rubber sphere of the ball.  
19 Usually the backing is formed by using 100% cotton  
20 warp yarns, but alternatives such as polyester and  
21 nylon could be used.

22  
23 The tennis ball felt is then preferably dyed with a  
24 fluorescent dyestuff. That is, the coloured felt  
25 will absorb ultra-violet light and re-emit the  
26 absorbed energy in the visible area of the spectrum.  
27 Most tennis balls are now covered with felt that is  
28 dyed fluorescent yellow and which produces peak  
29 reflectance values of over 100% in the yellow area of  
30 the spectrum.

31

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1 Few manufacturers produce fluorescent dyestuffs  
2 suitable for both wool and polyamide fibres. To the  
3 best of the Applicant's knowledge all the major  
4 tennis ball felt manufacturers use the same class of  
5 dyestuff albeit from different dyestuff suppliers.  
6 This class of dyestuff gives a hue (colour) slightly  
7 to the green side of yellow.

8  
9 The cones in the human eye are mainly responsible for  
10 daylight colour vision and these give the eye the  
11 highest visual efficiency in the yellow wavelengths.  
12 In addition to percentage reflectance three other  
13 values can be plotted to identify a colour:

14  
15 | Lightness, with a scale of 0 to 100, 0 being black  
16 and 100 white;

17  
18 Hue, which can be shown as a circle with red at 0  
19 degrees and yellow, green and blue at 90 degree  
20 intervals from this, the exact angle therefore  
21 indicating the hue. If the lightness is visualised  
22 as a vertical axis passing through the centre of the  
23 hue circle, then a colour can be plotted in three  
24 dimensional space; and

25  
26 | Chroma or colour saturation which can be shown as the  
27 distance along a given radius from the centre of the  
28 hue circle.

29  
30 In the mid 1990's a high visibility yellow felt (or  
31 Hi.Viz. F/Y) was produced using an increased

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1 percentage of dyestuff. This felt (or Hi.Viz. F/Y)  
2 has a higher level of saturation (chroma) but  
3 actually has a slight reduction in peak reflectance  
4 and in lightness when compared to some standard  
5 coloured felt.

6

7 A method has now been found which allows the  
8 production of coloured felt for tennis balls having  
9 enhanced visibility properties over the prior art.

10

11 The invention also provides a method of dyeing  
12 material which produces an Ultra High Visibility  
13 (UHV) felt which mitigates shortfalls of previously  
14 available dyed felts.

15

16 More particularly, the invention provides a method of  
17 dyeing fabric material (particularly fabric material  
18 which is suitable for use in sports ball manufacture)  
19 which method comprises contacting said fabric  
20 material with a bleaching agent prior to or  
21 simultaneously with contacting said fabric material  
22 with a dyestuff providing said colour. The term  
23 "fabric material" includes both piece goods, yarns  
24 and also fibres in loose form.

25

26 The present invention is based on the fact that the  
27 felt used to produce tennis balls typically has a  
28 significant wool content (usually 40% or higher). —  
29 However, the peak reflectance of natural wool fibre  
30 in the yellow area of the spectrum is typically  
31 around 75% due to the natural yellowish-tinge in even

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6

12

15

24

31

1 We have found that better quality fabric material is  
2 achieved with increased wool content - for example  
3 30% or higher by weight of weft yarn. Typically a  
4 wool content of 40% or above, for example 50% or 60%,  
5 by weight of weft yarn achieves good results. It may  
6 be desirable to use fabric having a wool content of  
7 over 45% by weight of weft yarn and in certain high  
8 quality fabric materials, like those used for high  
9 quality tennis balls, over 50% (usually around 60%)  
10 is used. In some cases the wool content may be even  
11 higher (e.g. over 65% or 70% by weight of weft yarn)  
12 and be 80% or over.

13  
14 For woven fabric, the warp yarn will typically be a  
15 cotton yarn, but polyester or polyamide (e.g. nylon)  
16 could alternatively be used. For non-woven fabrics  
17 (e.g. needlefelted fabrics) or knitted fabrics a  
18 lower wool content (for example in the range of 20-  
19 40% by weight, preferably at least 25%) may be  
20 sufficient. By "wool" we include wool-like fibres  
21 (e.g. angora, cashmere and mohair) as well as the  
22 more typical sheep's wool.

23  
24 Nylon fibres having a circular cross-section have  
25 been successfully used, but synthetic fibres having  
26 other cross-sections (e.g. triangular or flattened)  
27 are commercially available and may further increase  
28 the reflectance achievable.

29  
30 It is also preferred that the material is processed  
31 as described in piece form. Preferably the fabric is

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1 a felt and more particularly a felt suitable for the  
2 covering of tennis balls. Since a mixture of fibre  
3 types (wool and synthetic) are present in the fabric  
4 material, it is recommended to contact the fabric  
5 material also with a partitioning agent in order to  
6 eliminate or reduce the difference in uptake of the  
7 dyestuff between the different types of fibres. The  
8 bleaching agent, which is preferably a reduction  
9 bleaching agent, whitens the initial colour of at  
10 least the wool.

11

12 Preferably the fabric material is treated using a  
13 jet-dyeing apparatus and a liquor ratio of 6:1 to 8:1  
14 is used to run the machine.

15

16 It is further preferred that the pH is adjusted  
17 preferably between 4.2 and 4.5 by using, for example,  
18 formic acid. The temperature is then raised to a  
19 suitable temperature, for example about 45°C, and  
20 held for a period of, typically, 3 minutes to be able  
21 to check and if necessary adjust the pH.

22

23 A wide range of suitable partitioning agents are  
24 available depending for example upon the nature of  
25 the material to be treated. However the partitioning  
26 agent sold under the Trade Name BASOPAL NA by BASF  
27 plc of Cheshire, SK8 6QG, United Kingdom, has  
28 demonstrated good results. BASOPAL NA is an  
29 alkylarylsulphonate in water and comprises 50-60% by  
30 weight of the salt of dodecylbenzenesulphonic and  
31 triethanolamine. The concentration of BASOPAL NA

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1 recommended is about 0.5 grams per litre of liquor.  
2 Alternative partitioning agents include THIOTAN RMFN  
3 LIQUID (an anionic sulphated fatty acid, pH 7 to 8 at  
4 10% dilution) to be used at a concentration of 3.0 to  
5 0.1% (o.w.f.); and ERIONAL RF of Ciba Speciality  
6 Chemicals Inc, Basel, Switzerland (an anionic  
7 condensation product of aromatic sulphonic acids and  
8 formaldehyde, pH 3.5 at 5% solution) to be used at a  
9 concentration of 0.5 to 6% gram per litre liquor.

10

11 It is further preferred that the bleaching agent and,  
12 if appropriate, the partitioning agent be in contact  
13 with the material for a reasonable length of time  
14 (typically from 1 to 30 mins) prior to the dyeing  
15 step being executed.

16

17 It is further preferred that the bleaching agent be  
18 added simultaneously or quasi-simultaneously with the  
19 partitioning agent.

20

21 The bleaching agent preferably used is the one sold  
22 under the Trade Name LUFIBROL FW by BASF plc of  
23 Cheshire, SK8 6QG, United Kingdom. LUFIBROL FW is an  
24 inorganic reducing agent with chelating agents and  
25 comprises 30-40% by weight tetrasodium ethylene-  
26 diaminetetraacetate and 30-40% by weight disodium  
27 disulphite. The amount of LUBRIFOL FW used is  
28 advantageously about 2% of the weight of fibre.  
29 Alternative bleaching agents include LANALBIN BE  
30 powder (a non-ionic hydroxylamine derivative, pH 5.6-  
31 5.7 at 1 g/litre) to be used at a concentration of

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1 1.0 to 4.0% (o.w.f.); and ERIOCLARITE B of Ciba  
2 Speciality Chemicals Inc of Basle, Switzerland (an  
3 anionic mixture of sodium metabisulphite with the  
4 sodium salt of ethylenediamine tetraacetic acid, pH 6  
5 at 5% solution) to be used at a concentration of 0.5  
6 to 1 g/litre.

7

8 It is preferred to use a fluorescent dye.

9 It is further preferred to use a yellow dye, as this  
10 colour is highly desirable for the manufacture of  
11 tennis balls. The preferred yellow dye which can be  
12 used according to the invention is a dye having a  
13 colour index number acid yellow 250, for example the  
14 one sold under the Trade Name NYLOMINE FLAVINE C-7G  
15 dyestuff by BASF plc, of Cheshire, SK8 6QG, United  
16 Kingdom. The dyeing step can be performed according  
17 to the recommended practice. A typical method is to  
18 add the dyestuff to the material and the liquor  
19 according to a recommended concentration and the  
20 temperature is then raised to the recommended level  
21 and held for some time at this temperature before  
22 rinsing.

23

24 The method of the invention also provides a white  
25 fabric material having enhanced visibility  
26 properties. The method is similar to that described  
27 above except that the "dyestuff" referred to is an  
28 optical brightening agent. Optical brightening  
29 agents are commonly used in the dyeing industry. The  
30 brightening agent sold under the trade name UVITEX

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1 NFB by Ciba Speciality Chemicals Inc of Basle,  
2 Switzerland can advantageously be used.

3  
4 The invention also relates to the dyed material,  
5 preferably a felt, and more preferably a woven felt,  
6 obtained according to the method of the invention  
7 which is coloured, preferably in yellow, and displays  
8 enhanced visibility properties.

9  
10 The invention further relates to the use of coloured  
11 fabric material dyed according to the method of the  
12 invention in the manufacture of articles such as  
13 sporting articles and more particularly tennis balls.

14  
15 The invention further relates to sporting articles  
16 comprising the dyed fabric material, and more  
17 particularly to sports balls (in particular tennis  
18 balls) covered with such material.

19  
20 The present invention provides a fabric material  
21 suitable for use in sports ball manufacture, wherein  
22 said material includes wool fibres and exhibits the  
23 following characteristics:

24  
25 a) for a coloured (non-white) fabric material:

- 26  
27 i) a chroma value of 100 or more;  
28 ii) a lightness value of 95 or more; and  
29 iii) a reflectance value of 120 or more, or

30

31 b) for a white fabric material:

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- 1           i)    a chroma value of 14 or less;  
2           ii) a lightness value of 85 or more; and  
3           iii) a reflectance value of 100 or more.  
4

5       When the dyed material is a woven fabric having warp  
6       and weft yarns, a wool content of at least 20%  
7       (usually 25%) by weight of weft yarn is required.  
8       Desirably, the wool content includes at least 30% or  
9       more, preferably 40% or more, by weight of weft yarn.  
10      It may be desirable to use fabric having a wool  
11      content of over 45% by weight of weft yarn and in  
12      certain high quality fabric materials, like those  
13      used for high quality tennis balls, over 50% (usually  
14      around 60%) is used. In some cases the wool content  
15      may be even higher (e.g. 65% or 70% by weight of weft  
16      yarn) and be 80% or over.  
17

18      For non-woven fabric the minimum amount of wool  
19      required is about 20% by weight. Desirably, the wool  
20      content includes at least 30% or more, preferably 40%  
21      or more, by weight. It may be desirable to use over  
22      45% by weight of wool and in certain high quality  
23      fabric materials 50% by weight of wool, or even 60%  
24      by weight of wool (e.g. 65% by weight of wool or even  
25      up to 70% by weight of wool) may be employed.  
26

27      For a coloured (non-white) fabric material the chroma  
28      value may be higher than 100 (for example 102 or  
29      more, preferably 105 or more) and, generally, a high  
30      chroma value is desirable provided that the minimum  
31      lightness and reflectance values given above for a

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1 coloured (non-white) fabric material are maintained.  
2 We have achieved a chroma value of over 110,  
3 specifically a value of 113.4.

4  
5 Likewise, for a coloured (non-white) fabric material  
6 a lightness value of greater than 95 is desirable  
7 (for example of 96 or more, or even 97 or more)  
8 provided that the minimum chroma and reflectance  
9 values given above for a coloured (non-white) fabric  
10 material are also maintained.

11  
12 Similarly, for a coloured (non-white) fabric material  
13 a reflectance value of over 120 (for example 125 or  
14 more, preferably 128 or more) is desirable provided  
15 that the minimum lightness and chroma values given  
16 above for a coloured (non-white) fabric material are  
17 also maintained. We have achieved a reflectance  
18 value of over 129, specifically a value of 129.9.

19  
20 In a preferred embodiment, the coloured (non-white)  
21 fabric material according to the present invention  
22 exhibits the following characteristics:

- 23 i) a chroma value of 105 or more  
24 (preferably 110 or more);  
25 ii) a lightness value of 96 or more  
26 (preferably 97 or more); and  
27 iii) a reflectance value of 125 or more  
28 (preferably 128 or more).

29  
30 Preferably the coloured (non-white) fabric material  
31 is a yellow material.

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1 For a white fabric material, the chroma value is  
2 desirably lower than 10 (for example is 8 or less,  
3 preferably is 5 or less) and, generally, a low chroma  
4 value (indicating absence of colour) is desirable  
5 provided that the minimum lightness and reflectance  
6 values given above for a white fabric material are  
7 maintained.

8  
9 Likewise, for a white fabric material a lightness  
10 value of greater than 85 is desirable (for example of  
11 88 or more, 89 or more, or 90 or more) provided that  
12 the maximum chroma value and minimum reflectance  
13 value given above for a white fabric material are  
14 maintained.

15  
16 Similarly, for a white fabric material, a reflectance  
17 value of over 100 (for example 102 or more, 105 or  
18 more or 106 or more) is desirable provided that the  
19 maximum chroma value and minimum reflectance value  
20 given above for a white fabric material are  
21 maintained.

22  
23 In a preferred embodiment, the white fabric material  
24 according to the present invention exhibits the  
25 following characteristics:

- 26  
27 i) a chroma value of 8 or less  
28 (preferably 5 or less);  
29 ii) a lightness value of 92 or more  
30 (preferably 93 or more); and

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1                   iii) a reflectance value of 85 or more  
2                   (preferably 90 or more).  
3

4       The present invention further provides a sports ball  
5       having a fabric material surface (for example a  
6       tennis ball) wherein said sports ball is manufactured  
7       using a fabric material as defined above.  
8

9       In a further aspect, the present invention provides a  
10       sports ball having a fabric material outer surface  
11       (for example a tennis ball) wherein said fabric  
12       material forming said outer surface includes wool  
13       fibres and exhibits the chroma, lightness and  
14       reflectance value described above.  
15

16       In a further aspect, the present invention provides a  
17       sports ball having a white fabric material outer  
18       surface (for example a tennis ball) wherein said  
19       fabric material forming said outer surface includes  
20       wool fibres and exhibits the following  
21       characteristics :  
22

- 23           i)     a chroma value of 10 or less;  
24           ii)    a lightness value of 90 or more; and  
25           iii)   a reflectance value of 80 or more.  
26

27       When the dyed material is a woven fabric having warp  
28       and weft yarns, a wool content of at least 20%  
29       (usually 25%) by weight of weft yarn is required.  
30       Desirably, the wool content is at least 30% or more,  
31       preferably 40% or more, by weight of weft yarn. It

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1 may be desirable to use fabric having a wool content  
2 of over 45% by weight of weft yarn and in certain  
3 high quality fabric materials, like those used for  
4 high quality tennis balls, over 50% (usually around  
5 60%) is used. In some cases the wool content may be  
6 even higher (e.g. over 65% or 70% by weight of weft  
7 yarn) and be 80% or over.

8  
9 For non-woven fabric the minimum amount of wool  
10 required is about 20% by weight. Desirably, the wool  
11 content includes at least 30% or more, preferably 40%  
12 or more, by weight. It may be desirable to use over  
13 45% by weight of wool and in certain high quality  
14 fabric materials 50% by weight of wool, or even 60%  
15 by weight of wool (e.g. 65% by weight of wool or even  
16 up to 70% by weight of wool) may be employed.

17  
18 For a white fabric material, the chroma value is  
19 desirably lower than 10 (for example is 8 or less,  
20 preferably is 5 or less) and, generally, a low chroma  
21 value (indicating absence of colour) is desirable  
22 provided that the minimum lightness and reflectance  
23 values given above for a white fabric material are  
24 maintained.

25  
26 Likewise, for a white fabric material a lightness  
27 value of greater than 90 is desirable (for example of  
28 92 or more, 93 or more, or 94 or more) provided that  
29 the maximum chroma value and minimum reflectance  
30 value given above for a white fabric material are  
31 maintained.

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1 Similarly, for a white fabric material, a reflectance  
2 value of over 80 (for example 85 or more, 90 or more  
3 or 95 or more) is desirable provided that the maximum  
4 chroma value and minimum reflectance value given  
5 above for a white fabric material are maintained.

6

7 In a preferred embodiment, the white fabric material  
8 according to the present invention exhibits the  
9 following characteristics:

10

- 11 i) a chroma value of 8 or less  
12 (preferably 5 or less);
- 13 ii) a lightness value of 92 or more  
14 (preferably 93 or more); and
- 15 iii) a reflectance value of 85 or more  
16 (preferably 90 or more).

17

18 The invention as described above with reference to  
19 coloured (non-white) fabric material (both in respect  
20 of the fabric material per se and in respect of the  
21 sports ball having a fabric material outer surface)  
22 preferably refers to a yellow fabric material.

23 References to "yellow" refer to any non-white fabric  
24 material which is acceptable to the International  
25 Tennis Federation (I.T.F.) (since yellow is an  
26 accepted coloration of tennis ball according to the  
27 I.T.F.). However, this is not exclusive, and other  
28 coloured fabric materials (for example pink, green,  
29 blue, etc) are also encompassed.

30

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1 The present invention will be now further described  
2 with reference to the following, non-limiting example  
3 and Figures in which:

4  
5 **Figure 1** shows the reflectance curves of two prior  
6 art felts in ball form (Nos 2 & 3) compared with the  
7 Ultra High Visibility yellow felt (UHV F/Y) in fabric  
8 form (No 1) of the invention.

9  
10 **Figure 2** shows the reflectance curves of two other  
11 felts (Nos 4 & 5) produced by the Applicant and  
12 compared with the UHV F/Y felt (No 1) of the  
13 invention, all in fabric form.

14  
15 **Figure 3** shows the same data as Figure 2 but the data  
16 used to produce the curves are generated by the  
17 International Tennis Federation on their  
18 spectrophotometer.

19  
20 **Figure 4** shows the saturation (chroma) of the UHV F/Y  
21 felt (No 1) of the invention compared with the four  
22 prior art felts (Nos 2 to 5) used in Figures 1 to 3.

23  
24 **Figure 5** shows the lightness of the same five felts  
25 used in Figure 4.

26  
27 **Figure 6** is an attempt to illustrate the position on  
28 the colour circle by both chroma and hue of the five  
29 samples used in the comparative data shown in Figures  
30 1 to 5.

31

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1     **Example 1**

2     **Production of an ultra high visibility yellow felt**  
3     **according to the method of the invention**

4  
5     The felt used in this example is a fabric material  
6     having an back surface made mainly in cotton and a  
7     face side made of a wool and polyamide fibre felt  
8     (the face side of the fabric forms the external face  
9     of the ball). Only the face surface made of wool and  
10    polyamide felt needs to be coloured. Wool and  
11    polyamide are present in the weft in a ratio of about  
12    60:40 with respect to the weight of wool and  
13    polyamide fibres. The amount of cotton fibres in the  
14    material represents about 15 % of the total weight of  
15    the fabric material.

16  
17    The felt is dyed using acid dyes in piece form using  
18    a Softflow jet dyeing machine which is run at a  
19    liquor ratio of between 6:1 and 8:1. The liquor is  
20    the liquid in which the material is wetted before  
21    the addition of the dyestuff. In most cases and in  
22    particular in this example the liquor is water.

23  
24    The dyeing method used in this example is as  
25    follows:-

- 26       - The felt is entered into the machine cold and  
27       the liquor ratio as indicated above;  
28       - The pH is adjusted between 4.2 and 4.5 with  
29       formic acid;  
30       - The temperature is raised to 45°C and held for  
31       3 minutes whilst checking pH;

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1 - 0.5 grams per litre of BASOPAL NA (BASF) and  
2 2% by weight of fibre of Lufibrol FW (BASF) are  
3 added through the dosing system; and

4 - the machine is run for 5 minutes at 45°C.

5 The following dyeing method is then applied:

6 - 1.6% by weight of fibres of NYLOMINE

7 FLAVINE C-7G dyestuff is added through the  
8 dosing system during a period of 2 minutes;

9 - the temperature is raised at a rate of  
10 1.8°C per minute to 95°C and the machine is  
11 run for 30 minutes at this temperature;

12 - the temperature is decreased to 40°C at a  
13 rate of 2.5°C per minute; and

14 - the felt is rinsed twice with fresh water  
15 and unloaded from the machine.

16

#### 17 **Comparative data**

18

19 The colour characteristics of the felt dyed according  
20 to the above described method are shown in Figures 1  
21 to 6. Except for Figure 3, all data were measured by  
22 the Applicant using CIE (Commission Internationale  
23 d'Eclairage) CIELAB formula at a 10 degree  
24 reflectance angle using standard D65 illuminant.

25

26 Figure 1 shows reflectance curves of an UHV yellow  
27 felt (UHV F/Y) made according the method described in  
28 Example 1 and of two competing felts in the form of  
29 tennis balls produced respectively for the companies  
30 Tretorn Sport and Penn Racquet Sports under the Trade  
31 Names TRETORN TXT and PRO PENN. The felts used to

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1 cover these balls are produced by Textech Industries.  
2 We have found only minimal difference in the  
3 spectrophotometric measurements made between a fabric  
4 in sheet form and the same fabric when in the form of  
5 completed tennis balls.

6  
7 Figure 2 shows reflectance curves of the UHV F/Y felt  
8 used in Figure 1 and of two other yellow felts, a  
9 "standard" (Std.F/Y) one and an "high visibility" one  
10 (Hi. Viz. F/Y), both produced by the company Milliken  
11 (Woollen Speciality Products) under the respective  
12 Trade Names PLAYNE'S 14 and PLAYNE'S 45. These felts  
13 are used in the manufacture of tennis balls such as  
14 the ones sold under the Trade Names DUNLOP FORT  
15 (standard) and SLAZENGER WIMBLEDON (high visibility).

16  
17 Figure 3 shows the same data as Figure 2 but the data  
18 used to produce the curves are generated by the  
19 International Tennis Federation (ITF) on their  
20 spectrophotometer. This independent measurement shows  
21 good correlation with the Applicant's own data.

22  
23 Figures 4 and 5 show respectively the chroma and the  
24 lightness of the five tested felts.

25  
26 Figure 6 shows a graph displaying the combination of  
27 both chroma and hue performances of the five tested  
28 felts.

29  
30 As can be seen from Figures 1 to 6, the colour of the  
31 felt of this example of the invention demonstrates

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1 superior characteristics in all areas (i.e. chroma,  
2 hue lightness and reflectance). The performances,  
3 when compared to the closest prior art (i.e. the High  
4 Visibility felt manufactured by Milliken), are  
5 especially better for lightness and reflectance.

6  
7 Figures 2 to 4 & 5 show that the high visibility felt  
8 has a higher level of saturation (chroma) but  
9 actually has a slight reduction in peak reflectance  
10 and in lightness when compared to the standard colour  
11 felt. This disadvantage does not exist with the  
12 colour of the UHV felt.

13  
14 A summary table of the peak reflectance level,  
15 chroma, hue and lightness for the fabric according to  
16 the invention (UHV F/Y) and for the commercially  
17 available alternatives used above and a natural white  
18 tennis ball felt is given in Table 1 below.

19 Table 1

Product	Peak Reflectance Level	Chroma (Saturation)	Hue	Lightness
Natural White Tennis Ball Felt	78.46	8.9	92.4	87.8
Milliken Standard Yellow Felt (Std.F/Y)	122.4	98.2	108.8	96.5
Milliken High Visibility Yellow felt (Hi.Viz.F/Y)	119.8	112.0	101.3	94.2
→ UHV F/Y	129.9	113.4	104.7	97.9
Tretorn TXT Ball	113.1	100.9	104.5	93.6
Pro Penn Ball	124.4	95.8	108.1	95.7

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1 Thus, the UHV F/Y felt of this invention can be used  
2 for the manufacture of yellow tennis balls of  
3 improved colour properties, which is obviously highly  
4 desirable to tennis players. Such improved  
5 properties permit, during a game, a more easy and  
6 rapid catch (visualisation) of the incoming moving  
7 ball by the tennis player and thus a quicker reaction  
8 and positioning of the player with respect the ball.

9  
10 The method and the product thus produced according to  
11 the invention may be used for other purposes than  
12 covering tennis balls. The high visibility of colour  
13 material of the invention could also be used for  
14 producing other items than tennis balls, especially  
15 those where high visibility is important (for example  
16 footballs - especially for indoor use - basketballs  
17 and volleyballs).

18  
19 Alternative dyeing technologies may be used, and  
20 specific mention may be made of the following:

21  
22 1. Winch beck

23  
24 Winch beck dyeing is an alternative technology for  
25 dyeing piece goods and pre-dates the Softflow jet-  
26 dyeing apparatus. Whilst the dyeing method is  
27 essentially the same as for jet-dyeing the liquor  
28 ratio would be higher, normally 20:1 to 25:1.

29  
30 In simple terms, this is a vertical stainless steel  
31 tank; the top half of one side lifts up and down for

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1 access and the top is vented. A large roller known  
2 as a winch is contained within the top section.  
3 There is a heating coil in the bottom section.

4  
5 The tank is partially filled with water and the cloth  
6 is then passed over the winch roller, through the  
7 water and then back out of the machine. The two ends  
8 of the cloth are sewn together to make an endless  
9 rope. The winch is driven to continually rotate the  
10 rope through the water.

11  
12 Dyes and chemicals are pre-dissolved and then added  
13 to the water. Steam is passed through the heating  
14 coil to raise the bath temperature to 98°C. This  
15 temperature is held for 30-45 minutes, after which  
16 the tank is cooled by filling with cold water and  
17 then draining. This is repeated until a safe  
18 handling temperature is achieved after which the  
19 cloth is removed.

20  
21 Products used in the bath:

22  
23 Fluorescent yellow dyestuff - colouring material.  
24 Glauber salts - acts as a levelling agent.  
25 Formic acid - to lower the pH making the cloth more  
26 attractive to dyestuff.

27  
28 2. Loose stock machine

29  
30 This is a circular stainless steel tank (or vat),  
31 from 1 metre to 3 metres diameter, which is partially

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1 filled with water. The material, in the form of  
2 loose wool and/or nylon fibres, which have been pre-  
3 washed is loaded into a cage. This cage then has a  
4 lid attached and is placed inside the outer tank.  
5 Dyestuff and chemicals are pre-dissolved inside a  
6 header tank and then pumped into the tank and through  
7 the stock in the cage.

8

9 The temperature of the vat is raised to 98°C and held  
10 for 30-45 minutes. The dye liquor is drained and  
11 fresh cold water pumped through to rinse and cool the  
12 loose stock.

13

14 The products used are the same as for winch dyeing.

15

16 After dyeing the fibres are processed into fabric  
17 form.

18

### 19 3. Package dyeing

20

21 Yarn is wound onto a stainless-steel cylinder which  
22 is perforated, allowing the dyeing liquor to be  
23 pumped through the yarn package from inside to out  
24 and vice versa. The yarn package is loaded into a  
25 circular, stainless steel tank and then pre-dissolved  
26 dyes and chemicals are pumped in.

27

28 The temperature of the liquor is raised to 98°C by a  
29 steam heating coil. This temperature is maintained  
30 for approximately 1 hour. The packages are then  
31 rinsed with cool water to cool the bath and remove

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- 1 residual dyestuff. The batch is left to drain and
- 2 then removed from the vessel.
- 3
- 4 Products used are the same as for winch dyeing.

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